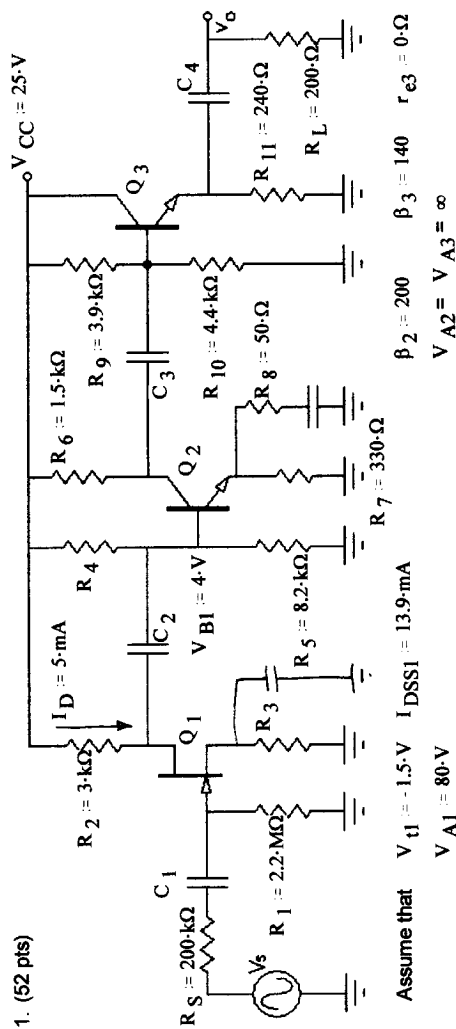


1. (52 pts)



a) What is the input resistance of the first stage (Q_1)? $R_{i1} = ?$

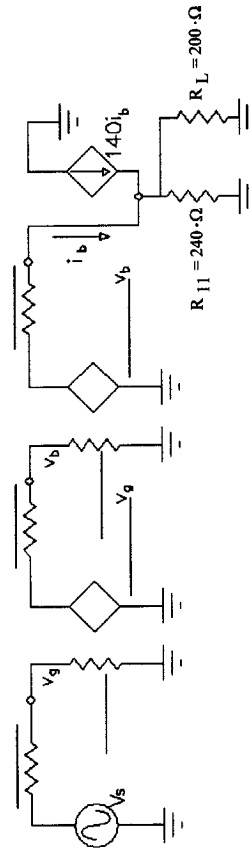
b) What is the output resistance of the first stage? $I_D = 5\text{ mA}$, $V_{A1} = 80\text{ V}$, $R_{o1} = ?$

c) $I_D = 5\text{ mA}$, what is the value of R_3 ? $R_3 = ?$

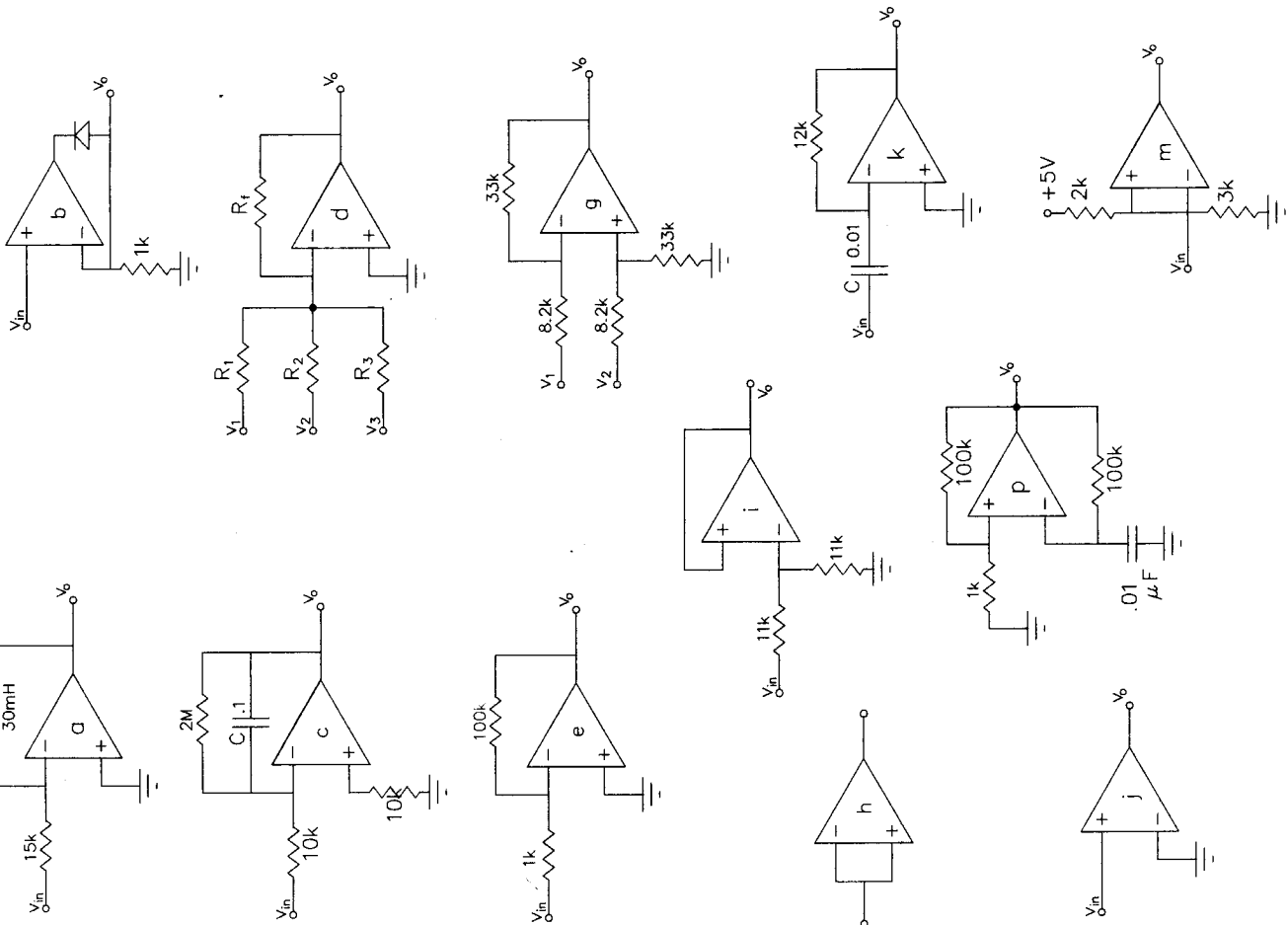
d) The DC bias voltage at the base of Q_2 is 4 V . What is the emitter current (I_E), the approximate collector current (I_C), and the base current (I_B)? $V_{B2} = 4\text{ V}$, $I_{E2} = ?$, $I_{C2} = ?$, $I_{B2} = ?$

e) What is the value of R_4 ? $R_4 = ?$

f) Fill in the resistor blanks in the small signal model below with numbers. Fill in the dependent source blanks with numbers and the controlling factor. Add arrows or polarity marks. I've done most of the third stage since we didn't cover that model well in class. The input resistance of the second stage (Q_2) is $R_{i2} = 3.9\text{ k}\Omega$



2. (38 pts) The previous page shows a number of op amp circuits, each labeled with a letter (a, b, c,...). Answer the questions below by listing the letters of the circuits that apply. Each circuit may be used in any number of answers and each question may be answered by any number of circuits, or, none at all. Make reasonable assumptions concerning the op amps and the input voltages. No calculations are necessary. (-2 pts per missing letter, -2 pts per wrong letter)



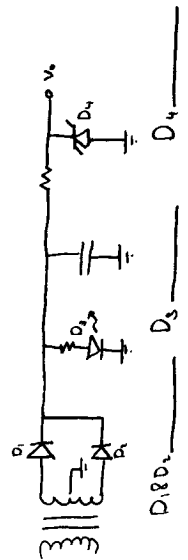
- Which circuit(s) are linear*? _____
*operate in the linear region of the op amp's transfer characteristic.
- Which circuit(s) are non-linear*? _____
- Which circuit(s) make no sense*? _____
*don't perform any useful or predictable operation if made with a real op amp.
- Which circuit(s) act as digital comparators? _____
- Which circuits act as frequency filters*? _____
*frequency response set by components external to the op-amp.

The following have one, and only one, right answer (3 pts each)

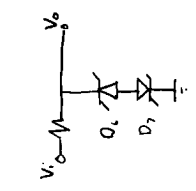
- Which circuit oscillates? _____
- Which circuit amplifies the sum of two or more signals? _____
- Which circuit amplifies the difference of two signals? _____
- Which circuit has a corner frequency or bandwidth of about 10 kHz? _____
Assume $f_T = 1\text{MHz}$

3. (32 pts) A number of diodes are shown in circuits below. You will also find a list of words which may describe the function of the diode in the circuit or the type of diode. For each of the diodes, find its primary function (lower case letter) and/or type (upper case in the list and write the letters (a through Z) in the space provided near the diode. Normal diodes will have one answer, special diodes will have two, except where noted. (2 pts per answer)

Answers may be used more than once.
(Some answers are subject to interpretation and will be accepted in more than one way)

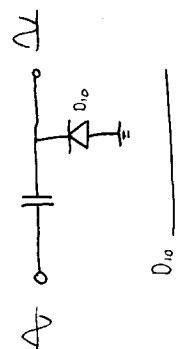


D_1 & D_2 _____ D_3 _____ D_4 _____

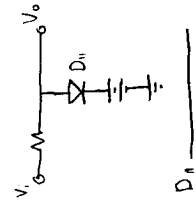


D_5 _____

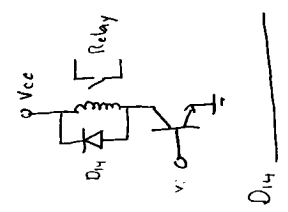
D_6 & D_7 _____



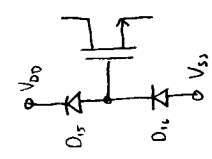
D_{10} _____



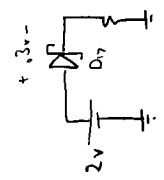
D_{11} _____



D_{14} _____



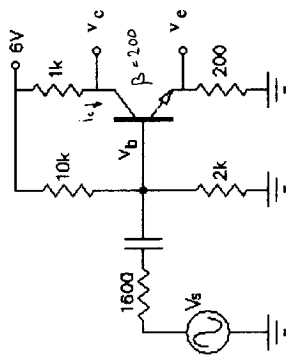
D_{15} & D_{16} _____



D_{17} _____
(one answer, type only)

4. (24 pts) Draw the indicated waveforms for the common emitter amplifier shown below. I have started by drawing V_E , you draw the others in a similar manner, showing both the dc bias and the ac signal.

The vertical dotted lines are important times, and your waveforms will be judged for accuracy at those times. Make sure the value of your waveform is clear at each of those times. Between those times it can be quite rough. You may neglect t_E .



V_E

V_B

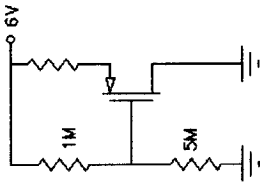
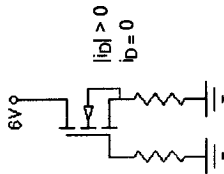
V_E

I_C

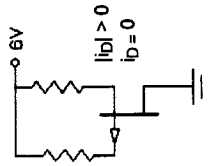
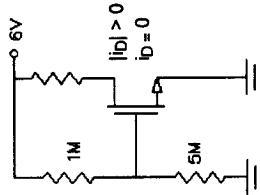
V_C

V_C

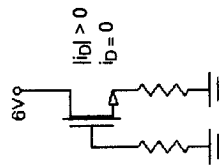
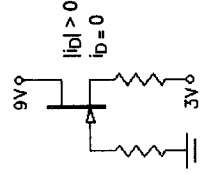
5. (18 pts) A number of FETs are shown in circuits below. Determine which FETs are biased on ($i_D > 0$). $V_t = -2\text{ V}$ or $V_t = +2\text{ V}$, whichever fits the type of FET. Neglect tiny effects on i_D like leakage. Circle $i_D > 0$ or $i_D = 0$ for each FET.



$i_D > 0$
 $i_D = 0$



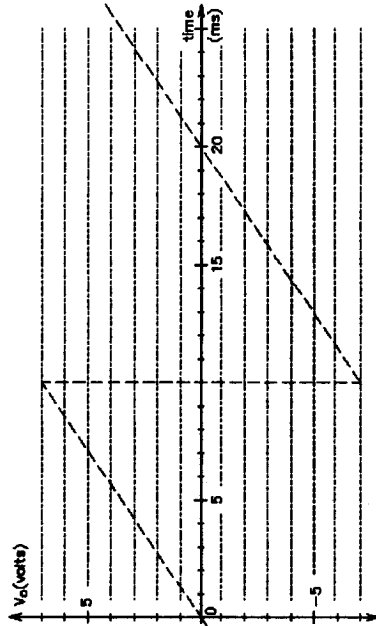
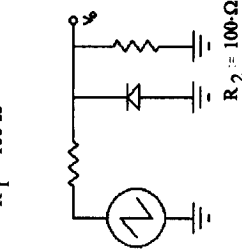
$i_D > 0$
 $i_D = 0$



$i_D > 0$
 $i_D = 0$

6. (16 pts) A voltage waveform (dotted line) is applied to the circuits shown. Accurately draw the output waveform (V_o) you expect to see. Use the constant-voltage-drop model for the silicon diode. Label important times and/or voltage levels.

$R_1 = 100\Omega$



3. e h f g h i j k l m n o p q r s t u v w x y z

a) $2.2M\Omega$

b) $2.53k\Omega$

c) $120.1\mu A$

d) $10mA, 10mA, 0.06mA$

e) $39k\Omega$

f) $200k$ $2.53k$ $1.5k$

$2.2M$ $29k$ $32.66V$

g) $acdegk$ f p

h) $bhijlm$ g d

i) hi h g

j) ja i e

k) ack

4. mid 0V up to 1V down to -1V
mid 1V up to 1.5V down to .5V, no clipping
given: mid .3V up to .8V down to 0V, clips @ 0V
mid 1.5mA up to 4mA down to 0mA, clips @ 0mA
mid: 4.5V, down to 2V, up to 6V, clips @ 6V

5. 0 0
0 0
0 0

6. 0.0; 10ms, 3.5V; 10ms - 7V; 20ms 0V



EE 2100 Final

Name _____

Scores:

page 1 _____ of a possible 52 pts

page 2 _____ of a possible 38 pts

page 3 _____ of a possible 56 pts

page 4 _____ of a possible 34 pts

Total _____ of a possible 180 pts